

## 1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

**Project title:** New cosmetic formulations and biomaterials based on natural ingredients with antioxidant properties

- 1.1. **Project goals:** The main goal of the project is to develop new cosmetic formulations and biomaterials using antioxidant compounds present in food waste and byproducts.
  
- 1.2. **Outline:** Cosmetic formulation and biomaterials with antioxidant properties are crucial in the treatment of aging skin and during fabrication the wound healing materials. The aim of this project is preparation of several cosmetic formulations and biopolymer films containing antioxidants extracted from food waste and byproducts and to study the skin and hair properties after topical application of the cosmetic formulation. An integral part of the work will be characterization of substances extracted from the raw materials and their antioxidative potential as the biologically active compounds. For chemical study the following instruments will be used: FTIR-spectrophotometer, UV-Vis spectrometer, XRD, SDS-Page electrophoresis, GPC chromatography, HPLC, AFM and SEM microscopy, apparatus for contact angle measurements, apparatus for measurements of mechanical properties of hair, UV-Vis spectrofluorimeter, apparatus for thermal analysis, rheometer, several viscometers, centrifuge for protein purification, lyophilizer. For the study of skin properties the following instruments will be used: corneometer, sebumeter, colorimeter, ARAMO TS for study the skin elasticity and general look.
  
- 1.3. **Work plan:** 1) extraction of natural compounds from the waste and byproducts of food; 2) purification and characterization of natural antioxidants; 3) study of preservative and antioxidant potential; 4) development of new cosmetic formulations and biomaterials based on selected natural ingredients; 5) study of the stability of cosmetic formulation in different conditions; 6) characterization of skin and hair properties after topical application of new product; 7) study the

properties for wound healing applications.

**1.4. Literature (max. 10 listed, as a suggestion for a PhD candidate)**

- K. Kulka, A. Sionkowska. Chitosan Based Materials in Cosmetic Applications: A Review. *Molecules* 2023; 28(4), 1817; <https://doi.org/10.3390/molecules28041817>
- M. Kurzawa, E. Wilczyńska, P. Brudzyńska, A. Sionkowska. Total Phenolic Content, Antioxidant Capacity and UV Radiation Protection Properties of Marigold (*Calendula officinalis*), Carrot (*Daucus carota*), Tomato (*Solanum lycopersicum*) and Hop (*Humulus lupulus*) Extracts. *Cosmetics* 2022; 9, 134. <https://doi.org/10.3390/cosmetics9060134>
- Ajay Kumar Sahi, Shravanya Gundu, Pooja Kumari, Tomasz Klepka, Alina Sionkowska. Silk-Based Biomaterials for Designing Bioinspired Microarchitecture for Various Biomedical Applications. *Biomimetics* 2023, 8(1), 55; <https://doi.org/10.3390/biomimetics8010055>
- Hau Trung Nguyen, Alina Sionkowska, Katarzyna Lewandowska, Patrycja Brudzyńska, Marta Szulc, Nabanita Saha, Tomas Saha, Petr Saha. The rheological characteristic and properties of chitosan blends modified by kombucha-derived bacterial cellulose. *Polymers* 2022; 14, 4572. <https://doi.org/10.3390/polym14214572>
- V.K. Anupama Devi, Sarbajit Ray, Udita Arora, Sunrito Mitra, A. Sionkowska, Amit Kumar Jaiswal. A. Dual Drug Delivery Platforms for Bone Tissue Engineering. *Frontiers Bioengineering and Biotechnology* 2022; 10:969843. doi: 10.3389/fbioe.2022.969843.
- A. Sionkowska, B. Kaczmarek, M. Michalska, K. Lewandowska, S. Grabska. Preparation and characterization of collagen/chitosan/hyaluronic acid thin films for application in hair care cosmetics. *Pure and Applied Chemistry* 2017; 89(12): 1829–1839.
- J. Kozłowska, K. Pauter, A. Sionkowska. Carrageenan-based hydrogels: Effect of sorbitol and glycerin on the stability, swelling and mechanical properties. *Polymer Testing* 2018; 67: 7-11.
- J. Kozłowska, A. Kaczmarkiewicz, N. Stachowiak, A. Sionkowska. Evaluation of sebostatic activity of *Juniperus Communis* Fruit Oil and *Pelargonium Graveolens* Oil Compared to Niacinamide. *Cosmetics* 2017 4(3), 36; doi:10.3390/cosmetics4030036.
- A. Filipiak-Szok, M. Kurzawa, E. Szłyk, M. Twarużek, A. Błajet-Kosicka, J. Grajewski. Determination of mycotoxins, alkaloids, phytochemicals, antioxidants and cytotoxicity in Asiatic ginseng (*Ashwagandha*, *Dong quai*, *Panax ginseng*). *Chem. Pap.*, 2017; 71 no. 6: 1073-1082.
- A. Filipiak-Szok, M. Kurzawa E. Szłyk, Simultaneous determination of isoquinoline alkaloids in medicinal Asiatic plants by ultrasound-assisted extraction and high-performance liquid chromatography – mass spectrometry with principal component analysis, *Analytical Letters*, 2018;16 (51): 2575-2585.

**1.5. Required initial knowledge and skills of the PhD candidate:** basic knowledge on analytical chemistry, cosmetic chemistry, biotechnology, cosmetology, pharmacy. Basic skills in laboratory work, knowledge of speaking and writing English.

**1.6. Expected development of the PhD candidate's knowledge and skills:** It is expected that the PhD candidate will learn new techniques of extraction and purification of natural compounds from food waste and byproducts. He/she will be able to use modern techniques for the characterization of the extracts and get skills for preparation of new cosmetic formulations and biomaterials. The knowledge of the PhD candidate will be developed base on international workshops and tutorials.